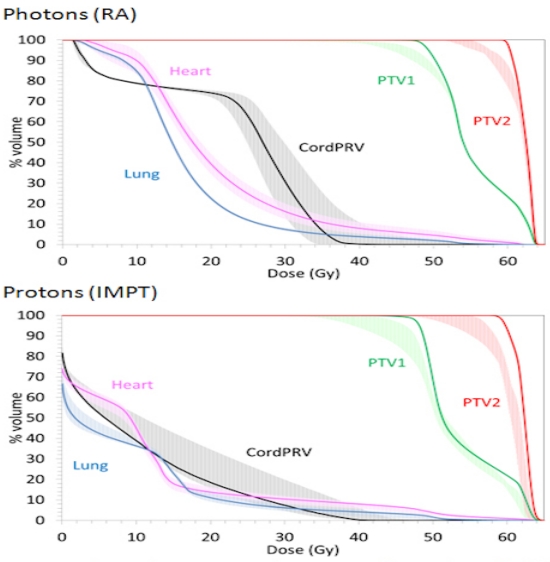

Dose-volume histograms for optimal SIB plans (solid lines) for a typical mid-oesophageal cancer patient. The shaded areas represent the range of DVH values for the uncertainty plans.

PD-0527

Evaluation tool for plan robustness regarding patient setup using Monte Carlo methods

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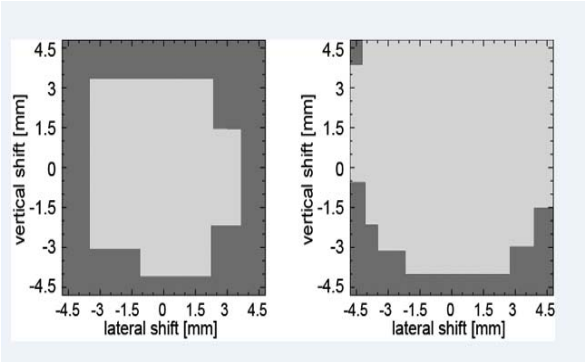
Purpose/Objective: Currently treatment plan evaluation is based on the inspection of the calculated dose distributions and dose volume histogram (DVH) parameters. The robustness with respect to setup uncertainties of the treatment plan is not taken into account in the evaluation process. Therefore the risk of missing the target or pushing dose to critical organs due to setup uncertainties is completely unknown. The purpose of this project is to develop a tool to assess the robustness of treatment plans taking into account random and systematic setup uncertainties.

Materials and Methods: In order to investigate the effect of random and systematic setup errors using Monte Carlo (MC) methods, the Swiss Monte Carlo Plan (SMCP) [1] was extended accordingly. The impact on the dose distributions is evaluated by calculating DVHs and dosimetric parameters as a function of the setup error phase-space. The evaluation tool allows specifying acceptance criteria by means of dose deviations from the original dose distribution. Based on these robustness-criteria, a robustness-map is generated dividing the setup error phase-space into two regions: one for which the robustness-criteria are met (acceptance-space) and another treatment-plan where the criteria are not fulfilled. A treatment-plan is more robust (in terms of the given robustness-criteria), compared to another if the acceptance-space is larger. In addition, deviations for DVHs or dose distributions compared to the original plan can be explored across the acceptance-space.

Results: The robustness evaluation tool is demonstrated on various cases and different tumor sites. As an example, Figure 1 shows the robustness map comparison of a 2 arcs and a 4 arcs plan for a head and neck patient using the VMAT delivery technique. In this case, the setup uncertainty phase-space was defined by translations between [-5mm, 5mm] along the x- y- and z-axis. The acceptance-space for the 4 arcs plan is significantly larger, i.e. more robust with respect to setup uncertainties. This is due to the fact that with the 4 arcs plan, a much better sparing of the spinal cord could be achieved.

Figure1: Robustness-map comparison for a head and neck treatment plan applying 2 arcs (left) and 4 arcs (right) using the VMAT delivery technique. The acceptance-space corresponds to the light grey colored area. The 4 arcs plan is superior compared to the 2 arcs plan under the given acceptance-criteria.



Conclusions: The construction and visualization of robustness-maps is useful to assess the robustness of RT treatment plans. This work is supported by Varian Medical Systems.

References

[1] Michael K Fix, Peter Manser, Daniel Frei, Werner Volken, Roberto Mini and Ernst J Born: An efficient framework for photon Monte Carlo treatment planning. Phys. Med. Biol. 52:N425-437, 2007

PD-0528

Beam set-up selection using Pareto fronts for robust proton therapy planning in cervical cancer

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Purpose/Objective: Cervical cancer patients may benefit from intensity-modulated proton therapy (IMPT), preferably using a patient-specific beam set-up. However, beam set-up optimisation is currently not part of the plan optimisation process and the influence of the number of beams on dose distributions after robustness evaluation is unknown. The aim of this study was to develop a method to determine the Pareto front (PF) of robust IMPT plans to enable beam set-up selection for robust proton therapy planning in cervical cancer.

Materials and Methods: Planning CTs of 3 cervical cancer patients treated in prone position with photons were used. Per patient, 3 robustly optimised IMPT base plans using different beam set-ups were created with a prescribed dose of 46 Gy (23 fractions) to the target (CTV). Beam set-ups, planning objectives and minimal requirements for evaluation, including the evaluation objectives of interest (CTV D99%, rectum V30Gy) which span the objective space, are listed (Table). For IMPT plans with a fixed beam set-up, only an approximation of the real patient-specific PF can be derived and an iterative method to approach this PF was written using the scripting facilities in RayStation (RaySearch Labs., Sweden). Starting with a base plan, multiple plans with new